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Symptom scoring systems to diagnose distal polyneuropathy in diabetes: the Diabetic Neuropathy Symptom score

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Abstract

Aims To provide one of the diagnostic categories for distal diabetic polyneuropathy, several symptom scoring systems are available, which are often extensive and lack in validation. We validated a new four-item Diabetic Neuropathy Symptom (DNS) score for diagnosing distal diabetic polyneuropathy.

Methods We compared score characteristics of the generally accepted Neuropathy Symptom Score (NSS) with the DNS score, and tested construct validity, predictive value and reproducibility with the Diabetic Neuropathy Examination score, Semmes–Weinstein monofilaments and Vibration Perception Threshold (clinical standards) in 73 patients with diabetes (24 Type 1, 49 Type 2; 43 male/30 female; mean age 57 years (19–90); mean diabetes duration 15 years (1–43)).

Results Correlation between NSS and DNS score was high (Spearman $r = 0.88$). Patient scores were more differentiated on the DNS score. The relation of the NSS and DNS scores, respectively, with clinical standards was good (Spearman $r = 0.21$–0.60). Reproducibility of the DNS score was high (Cohen weighted κ 0.78–0.95). The DNS score was easier to perform in clinical practice.

Conclusions The DNS is validated, fast and easy to perform, with a high predictive value when screening for diabetic polyneuropathy.

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Keywords diabetic neuropathy, symptom score, polyneuropathy, DNS score, DNE score

Introduction

Distal symmetric polyneuropathy is a common complication of diabetes and a major cause of diabetic foot ulcers [1,2]. When diagnosing neuropathy, the San Antonio Consensus recommended at least one measurement in five different diagnostic categories [3], including symptoms. Symptom scores should fulfil the criteria as described by Jaeschke, including validation (independent reference standard, adequate spectrum and number of patients, standardization, soundly based item selection), predictive value and practicality (reproducibility, performance in clinical practice) [4].

Several symptom scores have been developed to assess symptoms of diabetic neuropathy, including the Neuropathy Symptom Score (NSS) [5–8]. The latter has been widely studied and is known to be valid and sensitive. It is extensively used in clinical practice. Several adaptations are available such as the Neuropathy Symptom Profile, the Michigan Neuropathy Screening Instrument (MNSI) and the modified NSS scores of Veves and Young [9–12]. However, none of these scoring systems fulfils all Jaeschke's diagnostic criteria. Our aim was to validate a new, four-item Diabetic Neuropathy Symptom (DNS) score for diagnosing distal neuropathy in diabetes, and compare it with the NSS.

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Table 1 Patient characteristics

n	73
Mean age (years) (SD)	56.9 (16.1)
Min.–max. (years)	19–90
Mean duration DM (years) (SD)	14.9 (9.9)
Min.–max. (years)	1–43
Sex, male–female	43–30
Type DM 1–2	24–49
Mean HbA_{1c} (%) (SD)	8.7 (1.4)
Min.–max.	6.6–13.5
Retinopathy, %	40
Nephropathy, %	42
Peripheral vascular disease, %	38
Present or former ulcer, %	20

Patients and methods

Patients

We studied 73 patients with diabetes, covering the entire spectrum of secondary complications. Informed consent was obtained. Exclusion criteria were factors which may have interfered with the neurological condition other than neuropathy. Fifty patients were randomly selected from the diabetes out-patient clinic of the University Hospital Groningen. The other 23 all had obvious diabetic foot complications or clinical neuropathy, and attended the Rehabilitation Centre Beatrixoord. Patient characteristics are shown in Table 1.

Methods

The same researcher (J.W.G.M.) examined all 73 individuals. The symptom scores were obtained first, followed by clinical standards: a physical examination score (the Diabetic Neuropathy Examination (DNE) score) and quantitative sensory tests (Semmes–Weinstein Monofilaments (SW-MF) and Vibration Perception Thresholds (VPT)), respectively.

Symptom scores

NSS The NSS consists of 17 items, eight focusing on muscle weakness, five on sensory disturbances and four on autonomic symptoms [5,6]. Items that are answered negative/absent are scored 0, presence scored as 1 point. The maximum score is 17 [5–8].

DNS score An expert panel developed a four-item symptom score for diabetic neuropathy, consisting of a diabetologist, a vascular internist, a neurologist and a physician for rehabilitation medicine. The DNS score has the following items: (i) unsteadiness in walking, (ii) pain, burning or aching at legs or feet, (iii) prickling sensations in legs or feet, and (iv) numbness in legs or feet. Presence is scored 1, absence 0, maximum score 4 points. Guidelines to use with the score are shown in the Appendix.

Clinical standards

The DNE score, SW-MF and VPT were chosen as clinical standards to study the construct validity of the symptom scores for neuropathy.

DNE score This is a validated, hierarchical physical examination score, identifying distal symmetric polyneuropathy [13]. It exists of eight items, two testing muscle strength, one a tendon reflex, and five sensation. The maximum score is 16. A score > 3 points is considered abnormal.

Semmes–Weinstein monofilaments These were tested on the plantar surface of the hallux and centrally at the heel (when necessary after removal of excessive callus), using standard guidelines [14–17]. We used the 'yes–no' method, meaning that the patient says yes each time he/she senses the application of a monofilament. Six trials were taken; when the patient was unable to respond correctly in more than one trial, a heavier monofilament was taken. The 1, 10 and 75-g monofilaments were used [14–17]. Insensitivity to the 10-g monofilament was defined as abnormal.

Vibration Perception Threshold VPT was tested using a hand-held biothesiometer at the dorsum of the hallux on the interphalangeal joint and at the lateral malleolus [18–20]. The voltage of vibration was increased until the patient could perceive vibration on three occasions. The mean of these was used to determine the VPT. Age-adjusted reference values were used [18–20], with values higher than the mean + 2 × SD (reference value) considered abnormal.

Reproducibility

To test reproducibility of the DNS score, inter- and intra-rater agreement was assessed in a separate study on 10 patients. The six women and four men, with a mean age of 50.0 years (SD 15.9) had a wide range of neuropathy severity. The mean duration of diabetes mellitus (DM) was 11.5 years (SD 10.5); three participants had Type 1, and seven Type 2 DM. Two doctors rated these on two occasions at 1-week intervals.

Statistical analysis

Internal consistency of the symptom scores was assessed by calculating Cronbach's α, and reliability coefficient ρ, which is comparable to α. The statistical package SPSS-PC was used to compute the descriptive statistics, reliability coefficient Cronbach's α, Spearman's correlation coefficient r, Student's t-test and ROC curves [21].

Inter- and intra-rater agreement was assessed using Cohen's weighted κ [22,23].

Results

The NSS and DNS scores, scored a mean (SD) of 1.9 (2.0), and 1.1 (1.3), respectively. The reliability of the DNS score (0.64) was somewhat lower than of the NSS (0.74). Correlation (Spearman r) between these two symptom scores was 0.88 ($P < 0.001$).

Relationship of NSS and DNS with the clinical standards

Spearman's correlation coefficient r for the DNE score with NSS and DNS score was similar at 0.56 and 0.60 (both $P < 0.001$), respectively. Scores between the monofilament, NSS and DNS scores were 0.21 (NS) and 0.25 ($P < 0.05$), respectively; and for VPT, 0.46 and 0.56 (both $P < 0.001$), respectively.

Table 2 The relation of clinical standards to symptom scores
DNE score

	n	Mean NSS (SD)	Mean DNS (SD)
0	24	0.92 (1.47)	0.42 (0.93)
1	48	2.42 (2.07)	1.52 (1.24)
		P = 0.002	*P* = 0.000
SW-MF hallux			
	n	Mean NSS (SD)	Mean DNS (SD)
0	45	1.42 (1.42)	0.84 (1.04)
1	25	2.64 (2.63)	1.56 (1.41)
		P = 0.014	*P* = 0.019
VPT hallux			
	n	Mean NSS (SD)	Mean DNS (SD)
0	39	1.28 (1.47)	0.67 (0.98)
1	32	2.63 (2.34)	1.69 (1.30)
		P = 0.004	*P* = 0.000

Group 0, Normal on clinical standard; group 1, disturbed on clinical standard.

The NSS and DNS scores predicted the clinical standards adequately (Table 2).

Sensitivity/specificity and reproducibility

Figure 1 shows the ROC curves of the NSS and DNS, respectively, compared with the DNE. The areas under the curve are 0.75 and 0.78 for NSS and DNS, respectively. Using the monofilament at the hallux these values were 0.62 and 0.65, respectively; and using VPT 0.68 and 0.73.

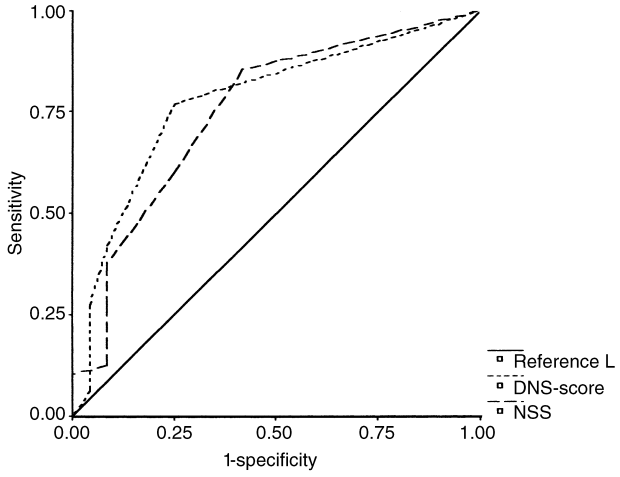

Figure 1 ROC curves of NSS and DNS scores in relation to the DNE score.

At a cut-off point of 0 vs. 1–4 for the DNS, sensitivity was 79% and specificity 78%, using the DNE. With the monofilament, sensitivity was 81% and specificity 56%, and VPT 81% and 58%, respectively.

The intra-rater agreement showed a Cohen's weighted κ for both raters of 0.89 and 0.78, the inter-rater agreement on two occasions was 0.95 and 0.83, respectively, indicating a good to very good level of agreement [22,23].

Discussion

The DNS and NSS scored similarly and both fulfil the Jaeschke criteria for diagnostic tests. Although the NSS has been validated previously and is widely accepted, it is probably too extensive to be used in every day clinical practice to diagnose neuropathy. Other, shorter scoring systems and modifications do not appear to fulfil the criteria for diagnostic tests. Thus, we propose the four-item DNS score as a fast and easy to perform symptom score with high reproducibility. The DNS has been validated using standard clinical methods, but might be too short to provide reliable follow-up when used alone.

Sensitivity and specificity of the DNS score were high when defined using other standard methods for evaluating neuropathy. Because the DNS score will be used for screening purposes, a high sensitivity is to be preferred. A score of 1 or more points on the DNS score is sensitive when identifying neuropathy. In combination with the results of the other diagnostic categories, classified by the San Antonio Consensus, the type and severity of neuropathy can be estimated. Unfortunately, the relative importance of different categories of the San Antonio Consensus in diagnosing diabetic neuropathy and predicting diabetic foot complications is unknown.

Controversy exists about the use of symptom scoring in diagnosing diabetic neuropathy [7,24–27]. In our report, significant and clinically relevant correlations were shown between the symptom scores and other methods which can predict diabetic foot complications. We believe that symptom scoring should complement other diagnostic categories for diabetic neuropathy [3].

However, symptom scores may be less reliable [3,4,8], due to their subjectivity. Using dichotomous scores may improve reproducibility [3], a feature of the DNS.

In conclusion, the DNS has been validated for cases of diabetic polyneuropathy, and is fast and easy to perform in clinical practice. However, it should be used in combination with other methods.

References

1 Boulton AJM. The pathogenesis of diabetic foot problems: an overview. *Diabet Med* 1996; **13**: s12–s16.
2 Caputo GM, Cavanagh PR, Ulbrecht JS, Gibbons GW, Karchmer AW. Assessment and management of foot disease in patients with diabetes. *N Engl J Med* 1994; **331**: 854–860.
3 Consensus Statement. Report and recommendations of the San Antonio conference on diabetic neuropathy. *Diabetes Care* 1988; **11**: 592–597.

4 Jaeschke R, Guyatt G, Sacket DL. Users' guides to the medical literature: how to use an article about a diagnostic test. *JAMA* 1994; **271**: 389–391.
5 Dyck PJ. Detection, characterization and staging of polyneuropathy: assessed in diabetics. *Muscle Nerve* 1988; **11**: 21–32.
6 Dyck PJ, Sherman WR, Hallcher LM, Service FJ, O'Brien PC, Grina LA *et al.* Human diabetic endoneurial sorbitol, fructose and myo-inositol related to sural nerve morphometry. *Ann Neurol* 1980; **6**: 590–596.
7 Dyck PJ, Karnes JL, Daube J, O'Brien P, Service JF. Clinical and neuropathological criteria for the diagnosis and staging of diabetic polyneuropathy. *Brain* 1985; **108**: 861–880.
8 Dyck PJ, Kratz KM, Lehman KA, Karnes JL, Melton LJ, O'Brien PC *et al.* The Rochester diabetic neuropathy study: design, criteria for types of neuropathy, selection bias, and reproducibility of neuropathic tests. *Neurology* 1991; **41**: 799–807.
9 Dyck PJ, Karnes J, O'Brien PC, Swanson CJ. Neuropathy Symptom Profile in health, motor neuron disease, diabetic neuropathy, and amyloidosis. *Neurology* 1986; **36**: 1300–1308.
10 Feldman EL, Stevens MJ, Thomas PK, Brown MB, Canal N, Greene DA. Practical two-step quantitative clinical and electrophysiological assessment for the diagnosis and staging of diabetic neuropathy. *Diabetes Care* 1994; **17**: 1281–1289.
11 Veves A, Manes C, Murray HJ, Young MJ, Boulton AJM. Painful neuropathy and foot ulceration in diabetic patients. *Diabetes Care* 1993; **16**: 1187–1189.
12 Young MJ, Boulton AJM, Macleod AF, Williams DRR, Sonksen PH. A multicentre study of the prevalence of diabetic peripheral neuropathy in the United Kingdom hospital clinic population. *Diabetologia* 1993; **36**: 150–154.
13 Meijer JWG, van Sonderen E, Blaauwwiekel EE, Smit AJ, Groothoff JW, Eisma WH *et al.* Diabetic neuropathy examination: a hierarchical scoring system to diagnose distal polyneuropathy in diabetes. *Diabetes Care* 2000; **23**: 750–753.
14 Birke JA, Sims DS. Plantar sensory threshold in the ulcerative foot. *Leprosy Rev* 1986; **57**: 261–267.
15 Kumar S, Fernando DJS, Veves A, Knowles EA, Young MJ, Boulton AJM. Semmes Weinstein Monofilaments: a simple, effective and inexpensive screening device for identifying diabetic patients at risk of foot ulceration. *Diab Res Clin Pract* 1991; **13**: 63–68.
16 Mueller MJ. Identifying patients with diabetes mellitus who are at risk for lower extremity complications: use of Semmes Weinstein monofilaments. *Phys Ther* 1996; **76**: 68–71.
17 Armstrong DG, Lavery LA, Vela SA, Quebedeaux TL, Fleischli JG. Choosing a practical screening instrument to identify patients at risk for diabetic foot ulceration. *Arch Intern Med* 1998; **158**: 289–292.
18 Goldberg JM, Lindblom U. Standardised method of determining vibratory perception thresholds for diagnosis and screening in neurological investigation. *J Neur, Neurosurg Psych* 1979; **42**: 793–803.
19 Bloom S, Till S, Sonksen P, Smith S. Use of a biothesiometer to measure individual vibration thresholds and their variation in 519 non-diabetic subjects. *BMJ* 1984; **288**: 1793–1795.
20 Young MJ, Breddy L, Veves A, Boulton AJM. The prediction of diabetic neuropathic foot ulceration using vibratory perception thresholds. *Diabetes Care* 1994; **17**: 557–560.
21 Hanley JA, McNeil BJ. A method of comparing the areas under the receiver operating characteristic curves derived from the same cases. *Radiology* 1983; **148**: 839–843.
22 Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977; **33**: 159–174.
23 Altman DG, ed. *Practical Statistics for Medical Research*. London: Chapman & Hall, 1997.
24 Mayfield JA, Reiber GE, Sanders LJ, Janisse D, Pogach LM. Preventive foot care in people with diabetes. *Diabetes Care* 1998; **21**: 2161–2177.
25 Valk GD, Nauta JJP, Strijers RLM, Bertelsman FW. Clinical examination versus neurophysiological examination in the diagnosis of diabetic polyneuropathy. *Diabet Med* 1992; **9**: 716–721.
26 Franse LV, Valk GD, Dekker JH, Heine RJ, van Eijk JTM. Numbness of the feet is a poor indicator for polyneuropathy in type 2 diabetic patients. *Diabet Med* 2000; **17**: 105–110.
27 Valk GD, Grootenhuis PA, Bouter LM, Bertelsmann FW. Complaints of neuropathy related to the clinical and neurophysiological assessment of nerve function in patients with diabetes mellitus. *Diab Res Clin Pract* 1994; **26**: 29–34.

Appendix 1 DNS score

The questions should be answered 'yes' (positive: 1 point) **if a symptom occurred more times a week during the last 2 weeks** or 'no' (negative: no point) **if it did not**

DNS-score and guidelines

1 Are you suffering of unsteadiness in walking?
need for visual control, increase in the dark, walk like a drunk man, lack of contact with floor
2 Do you have a burning, aching pain or tenderness at your legs or feet?
occurring at rest or at night, not related to exercise, exclude claudicatio intermittens
3 Do you have prickling sensations at your legs and feet?
occurring at rest or at night, distal>proximal, stocking glove distribution
4 Do you have places of numbness on your legs or feet?
distal>proximal, stocking glove distribution

Maximum score: 4 points; 0 points, PNP absent; 1–4 points, PNP present.